Research Methodology UE18CS400SG
Unit 4

Aditeya Baral

March 2022

1 Interpretation

Draw inferences from data carefully and write a report, expose relations and processes from findings and communicate analytical findings through a research report.

1.1 Meaning of Interpretation

- Draw inferences from collects facts after experimental study
- Concerned with relationship within data and study beyond data
- Establish continuity in research and exploratory concept
- Establish explanatory concepts
- Appreciate significance of one's findings
- Results in hypothesis for experimental research

1.2 Technique of Interpretation

1. Explain how generalization is done and concepts are formulated
2. Consider extraneous information while interpreting final results
3. Consult someone with insight into the study, should be honest to point out logical errors in arguments
4. Interpretation to be done only after considering all relevant factors affecting the problem (to avoid false generalization)

2 Report Writing

Case reports, book reviews, essays, editorials, letters, articles etc are report forms apart from scientific reports

Report	Research Report
Collection of facts to give clear and concise information to people who do not have full facts of the subject matter of the report. A report is for a specific audience, types include memos, meeting minutes, expense reports, etc	Written document or oral presentation based on a written document that communicates the purpose, scope, objectives, hypotheses, methodology, findings, limitations and finally recommendations of a research project to others.

Table 1: Differences between Report and Research Report

2.1 Categories of Report

- **Formal** – meticulously structured, focus on objectivity, organization, deeper details, written in proper style. A **technical report** is a *formal and organized documentation of the process, progress, results of research created to communicate to an audience important information about the work.*
- **Informal** – short, free-flowing messages, casual language style

2.2 Steps to Prepare a Report

1. Decide terms of reference
2. Conduct research
3. Write outline
4. Write first draft
5. Analyze data, record findings
6. Recommend course of action
7. Edit and distribute or publish

2.3 Characteristics of Research Report

- Accuracy, simplicity, conciseness
- Comprehensible, readable, complete
- Reliable and economical
- Timelines
- Logical content
- Should also possess:
  - Show originality

- Ready availability of findings
- Appropriate layout in accordance with objective
- No grammatical or logical errors
- Logical analysis of subject
- Index appended at the end
- Attractive, neat and clear

2.4 Guidelines for Writing Report

1. Objective
2. Minimize technical language
3. Present tense and active voice only
4. Data confidentiality
5. Revise and rewrite
6. Use visual aids

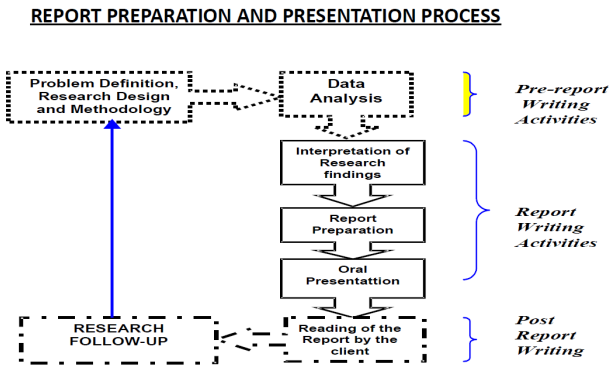

Figure 1: Report Preparation and Presentation Process

2.5 Types of Research Reports

2.5.1 Technical or Scientific Report

- A document that describes the **process, progress, or results of a research or the state of a technical or scientific research problem**
- Includes summary of results, nature of study, research methodology, details of data, analysis, conclusions, bibliography, appendix, index

2.5.2 Popular Report

- Emphasis on **simplicity and attractiveness, consists of clear writing, minimal technical and mathematical details, liberal use of charts and diagrams**, large print, cartoons
- Includes findings, recommendations, objective, methods, results, appendix

2.5.3 Interim Report

- **Short report to analyze how project is proceeding before completion**
- May contain first results of analysis
- Helps sponsoring agency to take action without full report, keeps their interest alive in study and prevent misunderstanding about delays
- Important in **medical trials** to ensure patients are not exposed to danger, and helps researchers find appropriate style of reporting

2.5.4 Summary Report

- Includes a **brief statement about problem, objective, background information, concise analysis, findings and conclusion**
- Aids managers in decision making, important part of business plans
- Short, limited size, published in newspapers

2.5.5 Algorithmic Research Report

- Problems exist in reality and solution to these problems can be expressed or obtained as an algorithm
- A report that contains the problem, algorithms used to solve the problem and the steps, implementation and findings

2.6 Report Structure

Abstract, Introduction, Method, Results, Discussion and Conclusion, References are needed. While writing, *start early, remember, read and reflect.*

1. **Preliminary pages** – title, acknowledgement, abstract, table of contents, list of tables, list of charts and figures
2. **Main text** – introduction, problem statement, literature survey, objectives, limitations, methodology, analysis, conclusion, bibliography, appendix

2.6.1 Writing Styles

- **General Report**
  - Double-spaced and numbered pages
  - Each section on new page with bold title
  - Ends with appendix, includes data, ethics approval form, other information
- **Research Report**
  - Title
  - Letter of transmittal
  - Table of contents
  - List of tables, graphs, appendices, exhibits
  - Executive summary – findings, conclusions, recommendations
  - Introduction - background and statement
  - Approach
  - Research design – information need, data collection, scaling techniques, pretesting, sampling, field work
  - Data analysis - methodology, plan
  - Results
  - Limitations
  - Conclusions and recommendations
  - Appendix

2.7 Scientific or Research Paper

First publication of original research results in a form where peers can repeat experiments and test conclusions in a journal or other document readily available to the scientific community

- **4 A's** – *Aim, Awareness, Audience, Articulation*
- Author's perspective – make research known
- Reader's perspective – read about research, findings, assess quality, give feedback, use in their own work
- Popular formats (people read in various orders)
  - **IMRaD** – introduction, methodology, results, discussion
  - **IRDaM** – introduction, results, discussion, methodology

Front portion with title, authors and abstract followed by main or core content with IMRaD

2.7.1 Title

- Few words (keywords), concise, crisp, specific but not narrow
- Captures relevant aspects of study without expectations
- Captivating, expressive, no extra words (articles, "studies" etc)
- Indexed in search engines or databases and important for literature search

2.7.2 Authors

Greatest to least contribution, head of group is listed last, use same name in all papers

2.7.3 Abstract

- Summary, widely read and important
- Helps identify content of a paper and determine relevance to one's current research work – should be consistent with main content
- Returned by search engines
- IMRaD format – objectives, method, results, conclusion
- No figures, charts, tables or references
- Do not copy-paste from main content, write after main content is written

2.7.4 Introduction

- Background to understand paper
- Highlight relevance and importance of work, no obvious facts
- Pose research question and motivate
- Short, general to specific content structure
- Identify knowledge gap, unknowns, attempts made
- How is problem solved, need for solving
- Key primary literature, investigate hypothesis
- Terms, definitions, clarifications
- Strong verbs and active voice, write after main content

2.7.5 Materials and Methodology

- Helps replicate and evaluate work
- Describe study design in detail so that work is reproducible
- Identify equipment, variables, metrics, analysis, sources, approvals, statistical methods
- Reason for methodology (should be sound – affects credibility and validity of results)
- Past tense, active voice, use tables and figures

2.7.6 Results

- Two parts – description of results and presentation of data
- Tables and figures
- Present results, do not add too much detail
- Organized order – answer the research questions
- No methodology, no raw data (present results/insights)
- Short, summarized, past tense

2.7.7 Discussion

- Answer research questions with justification based on results
- Explain research gap, questions, summary of findings and how it answers the questions
- Discussion and introduction are a pair (answers to questions)
- Limitations, relationship with other research, relevance of study
- Specific to general, active voice

2.7.8 Tables

- Should be understandable without text, self-explanatory
- Uniform format across paper, follow instructions to authors
- Add table number and caption

2.7.9 Figures

- Avoid too much information
- Ensure font size in image is readable when printed
- Add figure number and caption
- Follow instructions to authors

2.7.10 Acknowledgement

Thank people who helped with work but did not make contributions deserving authorship (example, financial support) after taking their prior permission.

2.7.11 References/Bibliography

- Give credit to other authors and add credibility to your own work
- Aids further reading on topic
- Use correct reference format

2.7.12 Active and Passive Voice

Use **active voice** for emphasis on important parts of a sentence and cut down word count. Use **passive voice** if the agent is unknown, unimportant or obvious, or is less important than the action or topic.

2.7.13 Keywords for Research Articles

- Indexed by search engines and used for quick retrieval
- Avoid terms in title (use alternate ones), ensure they are relevant
- Test keywords before submitting

2.8 Research Impact Factor (IF)

- **Article level metrics** – views, citations, Altemetric Attention score
- **Journal level metrics** – impact factor

Impact Factor *is the average number of times articles from the journal published in the past two years have been cited in the Journal Citation Report (JCR) year.*

It is calculated by dividing the number of citations in the JCR year by the total number of publications in the last 2 years.

$$Impact\ Factor(IF)_{year} = \frac{Citations_{year-1} + Citations_{year-2}}{Publications_{year-1} + Publications_{year-2}} \quad (1)$$

Impact Factor helps decide where to submit an article for publication, helps libraries make collection development decisions and helps academic departments assess academic productivity and make decisions on promotions and tenure.

3 Thesis Writing

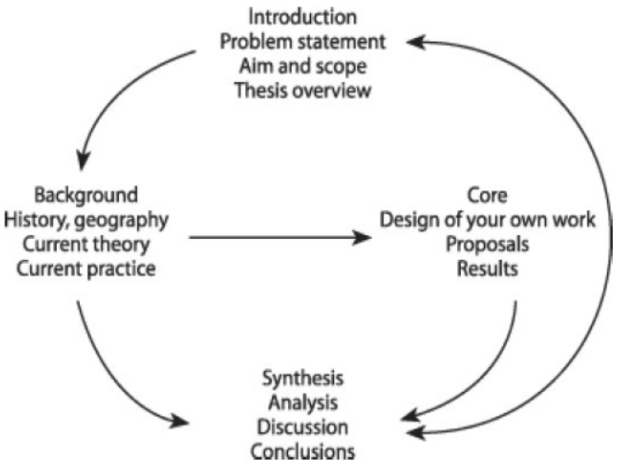

Figure 2: Thesis Structure

- An extended or persuasive argumentation on a research statement, focus, question, issue or topic
- Use evidence and reasoning to persuade committee on validity of research
- Demonstrate logical, structured, defensible reasoning and original contribution
- Submitted as a part of Degree (Bachelor's or Master's)
- Consists of main theme, in-depth treatment of aspects and is organized into chapters
- Judged by experts

3.1 Parts of a Thesis

3.1.1 Title

- Title and subtitle if any
- Author names

- Whether it is a Bachelor's/Master's thesis
- Faculty and department
- Place and date of completion

3.1.2 Approval Sheet

- Proves that the authors have passed the requirements needed for the thesis
- Signed by thesis/FS advisor, panel and Dean
- Also contains grade obtained

3.1.3 Abstract

- Brief summary of contents, not longer than 2 A4 pages
- 350 words for Ph.D. and 150 for Masters
- Provide important information (and no new information)

3.1.4 Acknowledgement

Express gratitude to organizations, agencies or individuals who aided researchers in their work.

3.1.5 Table of Contents

Topic outline of thesis – list headings to any level desired. 1" horizontal padding and 2" vertical padding to be used.

3.1.6 List of Tables/Figures

Add each list on a separate page – include number, caption, page number for each item listed.

3.1.7 Title of Chapters

1" horizontal padding, 2" from top page, 1" from bottom to footnote, 5" from bottom to page number

1. Problem and Background
2. Review of Related Literature and Studies
3. Methodology
4. Presentation, Analysis and Interpretation of Data
5. Summary, Conclusions and Recommendations

3.2 Title, Abstract and Keywords

Note – This subsection (slides 101 - 108) has mostly repeated content. All slides have been summarised into the following points. Read through.

- Words in title and abstract and keywords are indexed in search engines, databases – used to search for paper
- Mostly these sections are freely available online (people read before buying access to paper)
- First sections read by reviewers, editors
- **Title** should contain keywords, no filler, repetitive or junk words, crisp and concise, based on answers to research questions
- **Abstract** is marketing tool, helps decide if full paper is required to be read, summary of contents – why was it done, aim of study, what are the findings
  - **Descriptive** – used in social sciences and humanities reports, no information about methods and results
  - **Informative** – used in scientific reports, information on background, aim, methods, results and conclusions
  - **Structured** – used in medical sciences and clinical trials, divided into headings (objective, method, results, conclusion)
- Write abstract after full paper, include research problem and relevance, how was it solved, main findings, implications of findings. No figures, tables, extra information, abbreviations, citations
- Abstract should be consistent with main contents, meets guidelines given to authors, no errors
- **Keywords** should contain repeated or important terms or phrases, and variants of the same as well as abbreviations. Ensure terms are present in an indexing standard in the research discipline and also test on search engines for relevancy.

Research Methodology UE18CS400SG
Unit 5

Aditeya Baral

April 2022

1 Research Proposal

- Statement of intent on **what the study is about, why is it important, how it will be conducted and some insights on results**
- Concise, coherent summary and plan of proposed work
- Submitted to panel after initial studies, use future tense
- Helps clear thought process on micro levels – **familiarises background, justifies research, helps anticipate timeline, problems, design, experiments**

1.1 Format of Research Proposal

1. **Literature Review**
2. **Aim or Objectives**
3. **Proposed Methodology**– justify methods, prove feasibility
4. **Proposed Experimental Design**
5. **Timeline** – helps keep design in check, avoids dead time, consult others with work in same field
6. **Budget (if applicable)** – appreciation for research costs, prevents overspending, add explanations for each requirement

2 Ethics

- Research based on trust, be honest
- Follow **Code of Ethics – IEEE, ACM, 10 Commandments of Computer Ethics**

- **Authenticity and Accuracy** – report data for which experiments are carried out
- **Originality** – present your data only, give credits to others
- While citing, **indicate and quote exactly what material is taken from source** reference
- **No plagiarism** – no self-plagiarism either
- **Accurate, reproducible results** – include issues, drawbacks, limitations, unexpected and conflicting outcomes
- Provide **authorship based on contribution** to work and content
- Ethical treatment of humans and animals
- **Disclosure of conflicts of interest** – disclose commercial relations, grant proposals, opt for blind reviews (reviewers unknown to authors, authorship removed from paper before review)

3 Plagiarism

Appropriation of another person's ideas, processes, results, words, figures, illustrations without giving appropriate credit.

- Ethical issue and should be avoided
- Software exist to detect parts of a document with plagiarism – use to improve document
- **Cosine Similarity** used to measure similarity – θ gives the degree of similarity

$$Similarity = \cos\theta = \frac{\vec{A} \cdot \vec{B}}{\|A\| \, \|B\|} \tag{1}$$

- **Human interpretation required because of false positives**

4 Reference Management Tools

- Citations in our work must be according to **standard formats**
- Reference Management Tools **help organise and manage bibliographic resources, generates text citations and bibliography** as you write
- **Save bibliography from online databases** and can **switch between formats** easily
- Install plugin for integrating tool with word processor, and browser extension for importing references to tool

5 Scientific Misconduct

Violation of scholarly conduct and ethical behaviour in publication of scientific research

Scientific misconduct does not include errors, differences in interpretations, scholarly disagreements, opinions, authorship controversies.

5.1 Forms of Misconduct

5.1.1 Falsification

- Manipulation of research material, processes, or alteration or omission of observed results in an experiment
- Most common (over 40% cases of misconduct)
- Used to improve results or remove results contradicting hypothesis

5.1.2 Fabrication

- Invention of data, records or results
- Most commonly fabricated documents are consent forms and patient diaries

5.1.3 Plagiarism

- Copying someone's intellectual property (information or ideas) without citing source
- **Does not distort scientific knowledge** but is not ethical and harmful for careers

5.2 Reasons for Scientific Misconduct

- Academic, publication and career pressure
- Desire for fame, higher positions or financial gain
- Sloppy science
- Inability to determine right from wrong

5.3 Consequences of Scientific Misconduct

- Dismissal from faculty
- Rejection of research grants
- Blacklisting - from hiring, funding, publications
- Removal of past academic achievements

5.4 Measures to Maintain Research Ethics

1. **Before research** – develop research plan, submit protocols for research review, prepare with research community, agree on authorship, evaluate strength of grant
2. **During research** – Follow approved protocol, gain consent, regularly check data, involve research community, set standards for supervision, communicate expectations, establish an Office of Research Integrity
3. **After Research** – Share report, follow publication ethics like citing correct references

5.5 Why Research Misconduct Matters

- Difficult to recognize and prevent
- Undermines public trust in research
- Corrupts scientific records

5.6 Hazards to Good Scientific Practice

- Pressure of expectations, evaluation, publication, competition between research groups, positions and grants
- Involvement in commercialization, paid opinions, media presence, ambition
- Careless experimentation, inadequate and insufficient analysis, testing, awareness, ignorance of errors
- Preconceived opinions, failure to see unsuitability of data or results, emotion-driven judgement, arrogance and ambition

6 Intellectual Property Rights

6.1 Patents

- A **patent** is an **exclusive government granted monopoly right to make, use or sell an innovation for a limited area and time (20 years) by stopping others from doing the same**
- Patent rights are granted by **National Patent Offices**, hence patent protection for an invention must be sought in each country
- A patent can be bought, sold, licensed or mortgaged

- **Things that cannot be patented** – ideas, anything contrary to laws, morality, common knowledge, methods of agriculture, animals, plants, computer programs, schemes, rules, literary, artistic work
- **Ingredients of Patents**
  - Novelty and innovation
  - Lack of obviousness
  - Sufficiency of description

6.1.1 Reason for Patent

- Right to manufacture, import or sell
- Ability to enjoy monopoly of invention by exclusive rights
- Reduce competitors in market
- Revenue generation via licensing, assignment, technology transfer, mergers and acquisitions
- Confidence for venture capitalists, investors
- Increase value of company and build its image
- Key component in business strategies, helps protect company assets, allows company to operate from a strong position
- Encourage public interest in invention

6.1.2 Who can Apply for Patent

- Any person (regardless of citizenship) who is the true first inventor
- His assignee or legal representative
- Alone or jointly with another person

6.1.3 Procedure for Obtaining a Patent

1. Patent Application
2. Publication
3. Examination
4. Application in Order for Grant
5. Publication of Grant
6. Pre-Grant opposition
7. Post-Grant opposition

6.1.4 International Applications

PCT (Patent Cooperation Treaty) Application and Convention Application

6.1.5 Patent Application

- **Bibliographic information** – Date of filing, name and address, title, classification, abstract, formula, corresponding priority application or patent
- **Technical Information** – State-of-the-Art, description, drawings, claims

An application consists of:

1. Applicants
2. Inventors
3. Title
4. Address of correspondence
5. Priority particulars of applications
6. Particulars for filing PCT
7. Particulars for filing Divisional Application
8. Particulars for filing patent addition
9. Declaration
10. Attachments

6.1.6 Term of a Patent

20 years from date of priority, maintained by paying renewal fees every year

6.1.7 Patent Oppositions

1. **Pre-Grant Opposition**
    - **Filed by any person, after publication of patent application**
    - Filed on claims such as – wrongfully obtaining an invention, invention is anticipated, application does not disclose source, geographic origin, or inventive step
2. **Post-Grant Opposition**
    - **Can be filed by any individual involved in, or promoting work in the same field as the patent, after patent has been granted**
    - Same grounds as pre-grant opposition

6.1.8 Grant of Patent

- The exclusive right given for a period of 20 years that prevents unauthorized use of the technology
- **A patent needs to be granted for it to be effective** against infringement

6.1.9 Infringement of Patent

- Injunction (permanent or temporary)
- Damages to profits, seizure of business, destruction

6.2 Copyright

- **A copyright allows people to own their creative work and prevents others from reproducing it**
- Gives the creator control and monopoly by protecting literary, software, musical, motion picture, soundtracks, architectural etc works
- It is owned by the creator, but in the course of an employment is owned by the employer
- **Cannot be obtained for government works, ideas, concepts, common information with no originality, works that are not fixed**

6.3 Trademarks

- **A trademark is a symbol, image, sound, word or phrase, combination of colours or label legally registered and established that represents a company, product or business**
- Used to **distinguish the product from competitors**
- Owners of a trademark can sue for damages when infringements occur
- Any person claiming to be the owner of a product can apply for a trademark
  - Use the ™ symbol when application is underway (8-24 months)
  - Use the ® symbol once registered and registration certificate is obtained
  - Each trademark is valid for 10 years and can be renewed
- Registered by **Controller General of Patents Designs and Trademarks, Ministry of Commerce and Industry, Government of India**

6.3.1 Reasons for Trademark

- Identify the product and source for advertisement and branding
- Guarantees quality

6.3.2 Documents required for Trademark Application

- Trademark
- Applicant details
- Goods or services being registered
- Date of first use in India (if used prior to application)
- Power of attorney (needs signature of applicant)

6.3.3 Steps to register a Trademark

1. Select and authorize Trademark agent or attorney, who conducts a search for any existing or similar trademark.
2. If nothing is found, an application is drafted and filed by the Trademark attorney with Trademark Office who will also send you a receipt
3. After a few days, Original Representation Sheet of your trademark is sent by Trademark attorney to you, since it has been filed with Trademark Office
4. It can take between 18 months to 2 years for the Trademark Office to decide whether or not to grant you the trademark based on objections
5. After being accepted, it will be published in the Trademark journal

[1]

[1] A few things in the slides have been skipped in these notes - Laws, Acts, prices for patents, governing bodies etc since they did not seem important.